

Table 1. The number and frequency of nuclei per pollen grain from a random sample of 500 grains.

number	frequency
1 .....	340 (68%)
2 .....	58 (11.6%)
3 .....	7 (1.4%)
4 .....	95 (19%)
Total	500 (100%)

Table 2. The stainability and frequency of small and large pollen from a random sample of 500 grains.

stainability	frequency
small pollen	
+ stain .....	366 (94%)
— stain .....	23 ( 6%)
Total	389 (100%)
large pollen	
+ stain .....	98 (88.3%)
— stain .....	13 (11.7%)
Total	111 (100%)

## CHANGES IN FLORA OF THE MACHIAS SEAL ISLANDS

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Machias Seal Islands, at the entrance to the Bay of Fundy, have occupied a prominent place in ornithological literature ever since 1603 when they were named Les Isles des Perroquets or the Parrot Islands by Champlain. A number of studies were made here by Audubon, and at the present time, a bird sanctuary is maintained by the United States Govern-

<sup>1</sup>This research is part of a project entitled "Floristic and Phytogeographic Investigation of the Wolf Islands and Other Islands in the Bay of Fundy," which was supported in part by a grant from the Central University Research Fund of the Graduate School of the University of New Hampshire and in part by a grant from the Society of the Sigma Xi.

Published with the approval of the Director of the New Hampshire Agricultural Experiment Station, as Scientific Contribution No. 300.

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ment. Observations of plant life on these islands, when made, seem to have been buried in ornithological writings or have gone unpublished, as practically nothing appears in botanical journals or records.

As part of a phytogeographic survey of Islands of the Bay of Fundy, a short visit was made by the senior author to the Machias Seal Islands on 29 August 1960. The islands are hardly more than ledges, with only the larger one having any real soil or obvious terrestrial vegetation other than lichens and a few halophytic plants of rock-crevices.

These islands lie about ten miles off Cutler, Maine, and can be reached by small boats when the "Bay" is reasonably calm. Botanizing is more pleasant after the nesting season is over and the birds have departed sometime in August. Only the larger island was visited, the smaller one, called Gull Rock, being practically inaccessible; however, observations were made from the boat with binoculars. No trees or evidence of any trees nor any woody plants of any sort occur on these islands, not even the matted or prostrate shrubs such as *Juniperus horizontalis*, *Empetrum nigrum*, or *Vaccinium Vitis-Idaea*. Herbaceous plants in great vigor, however, occupied every available niche in 1960. Asters in spectacular profusion, in full bloom at the time, dominated the flora of the island and were easily the most conspicuous element of the vegetation. Many of the plants stood breast-high and individual clones varied from six to twenty feet across. The flowers were mostly in shades of blue and violet with some plants varying to pinkish or nearly white. Sentinels of matured *Coelopleurum* and *Rumex obtusifolius* were scattered throughout, with clumps of yarrow, the foliage so gigantic as to be almost unrecognizable. Plants of *Iris versicolor* with leaves six feet tall were noted. The extraordinary vigor and lushness of the herbage doubtless was due to the continual rain of guano during the early growing season, combined with the high humidity of the Fundian atmosphere. The only other conspicuous kind of vegetation was the well-kept lawn near the lighthouse which, at the time of the visit, was carpeted with euphrasias in full flower. During the short stay on the island on August 29, a total



of 34 species was collected as shown in the accompanying list.

The following year, a chance clue led to an exchange of communication with Dr. R. T. Clausen, who called our attention to a record of collections and a survey made in the years 1947-48 by Oscar Hawksley (Bird-Banding XXVIII No. 2 April 1957) as part of an investigation of the nesting habits of the Arctic Tern. In two years, 41 species of plants were collected. Hawksley stated on page 4, "an attempt was made to collect all the species of vascular plants on the island." Since his list was remarkably different in many respects from our list of 1960, a further survey was made to reconcile the two. On September 17, 1962, therefore, the senior author, this time with two experienced assistants, carefully combed the island. At the same time, a complete sampling of the aster clones was made for a later population analysis.

Sixty-two species as well as other minor taxa were collected, a marked increase over either previous list, but twelve species of Hawksley's list were still missing. The obvious procedure at this point would be to carefully study Hawksley's herbarium specimens, which we were informed were deposited in the Wiegand Herbarium at Cornell University. Unfortunately, the Curator, Dr. Clausen, reports that these are missing or perhaps were not left there. Not wanting to postpone this paper indefinitely, we prefer to proceed with our discussion of the Machias Seal Islands now, and in the event that this collection does come to light, make any necessary corrections in the list at that time.

The most noteworthy fact about the Machias Seal Island flora is the remarkable difference over an eighteen year period, which may be explained by any of the following reasons. The lists may be imperfect, resulting from fragmentary collecting or collecting only at one season. On the other hand, weed species may have come and gone or new ones arrived recently on an island that is so much visited. The climatic factors of one year may provide different growing conditions from another. The effect of domestic animals may have been most drastic, particularly in earlier years.



The interaction of the plants and the usually heavy breeding population of birds may result in periodic fluctuations of dominance of certain plant species.

Hawksley lists twelve species that we have been unable to find, while we are reporting 36 species not found by him. Several of Hawksley's twelve are species that might be expected, *Carex brunnescens*, *C. silicea*, *Urtica dioica*, *Iris Hookeri*, *Rumex crispus*, *Lathyrus palustris*, and *Euphrasia canadensis*, for example. But it is to be noted that a specimen of *Urtica viridis* Rydb. collected by Mrs. A. H. Norton is present in the Herbarium of the New England Botanical Club. Certainly these two nettles might easily be confused. It is also of interest that A. H. Norton (*Rhodora* 15:138, 1913) in recording observations of *Iris Hookeri*, made the following comment: "this plant . . . . . abounds on most of the islands (excepting Machias Seal Island) east of Petit Manan Point." A particular search for this species was made both in 1960 and 1962, but without success. Of course, it may exist in a precarious state of balance with other more vigorous vegetation. *Rumex mexicanus* may easily be confused with *R. pallidus*. Our material in good fruit proves to be the latter. *Cerastium vulgatum* was collected on both recent visits and occurs there in some abundance, and it could be that *C. viscosum* was confused with it. Although similar in general appearance, the common plant of seacoasts and low marine islands is *Potentilla Egedei* var. *groenlandica* rather than *P. anserina*. *Coelopleurum lucidum*, when immature, might be confused with *Heracleum*; we have not seen it on other small islands in the Bay of Fundy where *Coelopleurum* is common. The much greater list of 1962 may be explained in part by the advantages of getting more species in maturity and at a time when birds did not interfere with collecting and with the growth and development of plants.

The phenomena of plant succession and vigor were closely observed by Hawksley as they seemed to have direct bearing on his population study of Arctic terns. He noted a number of vegetational changes, some of the more violent of which were influenced by man and his domestic animals.



In 1944 there were 40 sheep on the island. In Hawksley's words (p. 85), "the vegetation . . . . . was close-cropped and much of it was destroyed completely." Recovery was apparent by 1946, and the following year the plant growth reached a height of 40 inches. A decline started in 1947 again with the aid of sheep (only four) and continued into 1949 with *Rumex Acetosella* and grasses replacing much yarrow.

Curiously enough, little mention is made of asters, which eleven and thirteen years later were the dominant herbage on much of the island. Even though asters would not have been in bloom during the months of Hawksley's visits, yet it would have been hardly possible to have ignored them when preparing a detailed vegetation map such as he made (Fig. 2, p. 63). He collected only one aster, and this species appears to be the minor one in the aster complex which was such a major feature in 1960 and 1962. One can only speculate as to what led to the appearance and rapid dominance of these asters.

Certain conclusions from this study bearing on island flora seem to be warranted. Even on a limited and isolated island, the composition of the flora under some conditions can apparently change to a considerable degree in a matter of only a few years. As a result of this work, one is led to wonder just what constitutes a definitive flora. The dynamics of floristic and vegetative change along with the uncertainty of making entirely complete collections show the danger involved in assuming a "flora" to be finished.

All specimens collected on the two visits in 1960 and 1962 are to be found in the Herbarium of the University of New Hampshire.

CONSOLIDATED FLORA OF MACHIAS SEAL ISLAND	HAWKSLEY 1947-48	PIKE 1960	PIKE 1962
<i>Osmunda cinnamomea</i> L.	X		X
<i>Festuca rubra</i> L. var. <i>rubra</i>	X		X
<i>Puccinellia paupercula</i> (Holm) Fern. & Weath. var. <i>alaskana</i> (Scribn. & Merr.) Fern. & Weath.			X
<i>Poa annua</i> L.		X	X
<i>Agropyron repens</i> (L.) Beauv. var. <i>subulatum</i> (Schreb.) Reichenb.	X		X



Agropyron repens var. subulatum forma Vaillantianum (Wulf. & Schreb.) Fern.		X	
Agropyron repens var. subulatum forma setiferum Fern.			X
Elymus arenarius L. var. villosus Mey.	X		
Calamagrostis canadensis (Michx.) Nutt. var. canadensis			X
Calamagrostis canadensis var. robusta Vasey			X
Agrostis alba L.			X
Agrostis alba var. palustris (Huds.) Pers.	X	X	X
Phleum pratense L.	X		X
Carex canescens L. var. canescens			X
Carex brunnescens (Pers.) Poir.	X		
Carex scoparia Schkuhr			X
Carex silicea Olney	X		
Carex hormathodes Fern.		X	X
Carex paleacea Wahlenb.		X	X
Juncus bufonius L.		X	X
Juncus bufonius var. halophilus Buchenau & Fern.			X
Sisyrinchium montanum Greene	X		X
Iris Hookeri Penny	X		
Iris versicolor L.	X	X	X
Urtica viridis Rydb. collected by Mrs. A. H. Norton, July 27, 1902 (NEBC).			
Urtica dioica L.	X		
Rumex mexicanus Meisn.	X		
Rumex pallidus Bigel.		X	X
Rumex orbiculatus Gray		X	X
Rumex crispus L.	X		
Rumex Acetosella L.	X	X	X
Polygonum aviculare L. var. littorale (Link) W. D. J. Koch		X	X
Atriplex patula L. var. patula			X
Atriplex glabriuscula Edmondston		X	X
Spergularia marina (L.) Griseb. var. leiosperma (Kindb.) Gürke		X	X
Arenaria lateriflora L.	X	X	X
Stellaria media (L.) Cyrillo	X		X
Stellaria graminea L.			X
Cerastium vulgatum L.		X	X
Cerastium viscosum L.	X		
Ranunculus repens L. var. villosus Lamotte			X
Ranunculus acris L.	X	X	X
Thalictrum polygamum Muhl.		X	X
Capsella Bursa-pastoris (L.) Medic.	X		X
Sedum Rosea (L.) Scop.	X	X	X
Potentilla norvegica L.	X		X



<i>Potentilla anserina</i> L.	X		
<i>Potentilla Egedei</i> Wormsk.			
var. <i>groenlandica</i> (Tratt.) Polunin		X	X
<i>Trifolium pratense</i> L.	X		
<i>Trifolium repens</i> L.	X	X	X
<i>Trifolium hybridum</i> L.			X
<i>Vicia augustifolia</i> Reichard		X	X
<i>Vicia Cracca</i> L.		X	X
<i>Lathyrus palustris</i> L.	X		
<i>Callitriche verna</i> L.			X
<i>Impatiens capensis</i> Meerb.	X	X	X
<i>Viola Mackloskii</i> Lloyd subsp. <i>pallens</i> (Banks) Baker	X		X
<i>Carum Carvi</i> L.	X		X
<i>Ligusticum scoticum</i> L.	X	X	X
<i>Coelopleurum lucidum</i> (L.) Fern.		X	X
<i>Heracleum maximum</i> Bartr.	X		
<i>Lycopus uniflorus</i> Michx.		X	X
<i>Euphrasia Randii</i> Robins.			X
<i>Euphrasia canadensis</i> Townsend	X		
<i>Euphrasia americana</i> Wettst.		X	X
<i>Rhinanthus Crista-galli</i> L.	X	X	X
<i>Plantago major</i> L.	X		X
<i>Plantago juncoides</i> Lam. var. <i>decipiens</i> (Barneoud) Fern.	X		X
<i>Galium tinctorium</i> L.		X	X
<i>Aster foliaceus</i> L. (complex)		X	X
<i>Aster johannensis</i> Fern.	X	X	X
<i>Aster umbellatus</i> Mill.			X
<i>Gnaphalium uliginosum</i> L.			X
<i>Achillea borealis</i> Bong.			X
<i>Achillea lanulosa</i> Nutt.	X		X
<i>Matricaria matricarioides</i> (Less.) Porter	X		X
<i>Cirsium arvense</i> (L.) Scop.	X	X	X
<i>Cirsium arvense</i> forma <i>albiflorum</i> (Rand & Redf.) R. Hoffman		X	
<i>Hypochoeris radicata</i> L.	X		
<i>Leontodon autumnalis</i> L.			X
<i>Taraxacum erythrospermum</i> Andrz.	X		
<i>Taraxacum officinale</i> Weber		X	X
<i>Sonchus asper</i> (L.) Hill			X